Ortuzar-Iragorri, Maria Arritokieta; Zamalloa, Teresa

Evolution in the Spanish primary education autonomic curricula and textbooks. A geographic analysis

CEPS Journal 13 (2023) 1, S. 143-161

Quellenangabe/ Reference:
Ortuzar-Iragorri, Maria Arritokieta; Zamalloa, Teresa: Evolution in the Spanish primary education autonomic curricula and textbooks. A geographic analysis - In: CEPS Journal 13 (2023) 1, S. 143-161 - URN: urn:nbn:de:0111-pedocs-264590 - DOI: 10.25656/01:26459; 10.26529/cepsj.1487

https://nbn-resolving.org/urn:nbn:de:0111-pedocs-264590
https://doi.org/10.25656/01:26459

doi: https://doi.org/10.26529/cepsj.1487

Evolution in the Spanish Primary Education Autonomic Curricula and Textbooks. A Geographic Analysis

Mª Arritokieta Ortuzar Iragorri*[1] and Teresa Zamalloa[2]

Evolution by natural selection is a theory that constitutes a powerful paradigm capable of conveying the teaching-learning of multiple concepts in biology. However, it has been controversial from its formulation to the present, which also affects education. For instance, while some of the basic curricula of primary education in Europe are arranged around the concepts that are considered necessary for structuring the scientific model of evolution (i.e., Sweden), other curricula do not contemplate such concepts. The last is the case of the basic curriculum of primary education in Spain. However, in Spain, on the basis of such a curriculum, there are 17 different primary education curricula corresponding to each of the autonomous communities of the state. The objective of this work is to state a detailed geographical picture of the presence of the concepts necessary to articulate the model of evolution through the analysis of the autonomic curricula of Spain. With such an aim, words that represent such concepts (evolution, inheritance, selection, adaptation and biodiversity, etc.) have been searched for in the natural sciences and social sciences areas of the autonomous curricula of primary education. Furthermore, a search for such evolution-related concepts has also been performed in the activities of eighteen Spanish primary education textbooks on natural and social science subjects. For this purpose, two aspects were considered: characterisation and scientific skills. Both the autonomous curricula of primary education and the textbooks hold important gaps when addressing evolution. The texts include activities that prioritise basic cognitive skills over the more demanding ones associated with scientific competence.

Keywords: primary education, autonomic curricula, progression, evolution model, textbooks

1 *Corresponding Author. Faculty of Education of Bilbao at University of the Basque Country, Spain; arritxu.ortuzar@ehu.eus.
2 Faculty of Education of Bilbao at University of the Basque Country, Spain.

Razvoj avtonomnih učnih načrtov in učbenikov v španskem osnovnošolskem izobraževanju – geografska analiza

Mª Arritokieta Ortuzar Iragorri in Teresa Zamalloa

Evolucija z naravno selekcijo je teorija, ki predstavlja močno paradigmo, sposobno transfera poučevanja – učenja več konceptov v biologiji. Prav od svoje formulacije in vse do danes pa ostaja sporna, kar vpliva tudi na izobraževanje. Medtem ko so na primer nekateri osnovni učni načrti osnovnošolskega izobraževanja (OI) v Evropi urejeni okrog konceptov, za katere se predvideva, da so bistveni za osnovanje znanstvenega modela evolucije (tj. na Švedskem), drugi tega niti približno ne odražajo. Zadnji tak primer za OI prihaja iz Španije. Tam na podlagi takega učnega načrta obstaja 17 različnih učnih načrtov, ki ustrezajo vsaki izmed avtonomnih skupnosti države. Cilj te raziskave je podati podrobno geografsko sliko prisotnosti konceptov, potrebnih za artikulacijo modela evolucije z analizo avtonomnih učnih načrtov Španije. S tem v mislih so bile besede, ki se sklicujejo ne te koncepte (evolucija, dedovanje, izbor, prilagoditev, biodiverziteta itn.), raziskane v sklopu naravoslovnih in družboslovnih znanosti znotraj avtonomnih učnih načrtov osnovnošolskega izobraževanja. Nadalje, lociranje tovrstnih konceptov je bilo opravljeno tudi z analizami 18 španskih osnovnošolskih učbenikov s področij naravoslovja in družboslovja. V ta namen sta bila upoštevana dva vidika: karakterizacija in znanstvena znanja. Tako avtonomni učni načrt primarnega izobraževanja kot učbeniki vsebujejo bistvene pomanjkljivosti, vrzeli pri obravnavanju evolucije. Besedila vključujejo dejavnosti, ki dajejo prednost osnovnim kognitivnim veščinam pred zahtevnejšimi, povezanimi z znanstveno usposobljenostjo.

Ključne besede: osnovnošolsko izobraževanje, avtonomni učni načrt, napredovanje, evolucijski model, učbeniki

Introduction

The theory of evolution is considered one of the greatest scientific achievements in the history of science because it changed the concept of fixed species and replaced it with the view that new species can arise from old species. It lies at the core of current biological knowledge and enables making sense of biological diversity and its change over time (National Science Teaching Association [NSTA], 2013). However, evolutionary theory tends to create a public controversy that makes teaching evolution a difficult task for teachers who need to consider various domains when teaching about it: a) the conceptual domain, which includes both scientifically accepted evolutionary concepts and students' non-scientific conceptions related to evolutionary theory, b) the epistemic domain, c) the worldview/religious domain, and d) the social and cultural domain (Deniz & Borgerding, 2018). This controversy has impacted education as the concepts necessary for the subsequent structuring of the scientific model of evolution are not contemplated in some of the European Primary Education (PE) curricula, including in Spain (Vázquez-Ben & Bugallo Rodríguez, 2018).

According to the Organic Law 8/2013 for the quality of Education (LOMCE) and the recent Organic Law 3/2020 that modifies it (LOMLOE), it is the duty of the Ministry of Education and Vocational Training to design the basic PE curriculum. Hence, the autonomous communities plan the autonomous curricula of Primary Education (APEC) based on the aforementioned basic curriculum (Eurydice, 2022). Thus, there are 17 different PE curricula for each of the 17 autonomous communities of Spain. They will soon be rearranged to meet the standards of the new law LOMLOE. Nowadays, autonomous curricula are organised into core and non-core subjects and, within them, blocks are established. Natural Sciences (NatSci) and Social Sciences (SocSci) are core subjects; the first has five blocks: i) introduction to scientific activity, ii) the human being and their health, iii) the living beings, iv) matter and energy, and v) technology, objects and machines; SocSci comprehends the following blocks: i) common contents, ii) the world we live in, iii) to live in society, and iv) traces of time. Thus, the contents related to evolution are approached both in the area of NatSci and SocSci.

Since evolution by natural selection enables understanding the complexity of biological processes and helps to explain multiple socio-scientific issues (Working Group on Teaching Evolution [WGTE], 1998), NatSci and SocSci classrooms are crucial for teaching about this topic. Furthermore, one of the objectives of science education is to aid students in becoming scientifically literate citizens so that they are able to engage with science-related issues, and with the ideas of science, as reflective citizens (Organization for Economic

Cooperation and Development [OECD], 2019). Such a goal requires not only knowledge about scientific concepts and theories but also about scientific practices and how they enable science to advance (Jiménez-Aleixandre & Crujeiras, 2017), as well as being able to apply them in a variety of contexts and situations (De Pro, 2013). Thus, selecting socio-scientific issues that induce the student to intervene to solve them contributes to the development of critical thinking (Blanco López et al., 2017). In fact, Sadler (2005) suggested that students' understanding and acceptance of evolution can significantly influence how they negotiate and resolve socio-scientific issues.

Therefore, teaching must involve students in authentic scientific practices that need to provide opportunities for students to use inquiry skills to generate new ideas in response to questions or problems and to evaluate their validity using arguments based on empirical evidence but also to model outlines in order to generate explanations from the existing evidence (Osborne, 2014). In fact, Gilbert (2004) states that the science curriculum should be structured to facilitate students' progress towards expert modelling status. To achieve it in evolution, a specific progression of ideas is described by the Next Generation Science Standards (NGSS) (NGSS Lead States, 2013) of the United States of America, which, like Spain, is part of the OECD. The NGSS are not a curriculum, but a series of objectives and good practices, which include the following core ideas for evolution: inheritance of traits, variation of traits, evidence of common ancestry and diversity, natural selection/artificial selection, adaptation, and biodiversity and people (Vázquez-Ben & Bugallo-Rodríguez, 2018).

Unfortunately, there is a consensus regarding the poor results obtained from compulsory education in many countries in terms of the meaningful learning of evolution (Alters & Nelson, 2002; Smith, 2010). One of the different factors that have been identified as a possible cause is the inadequacy of teaching materials, including textbooks (Demastes et al., 1995; Nehm & Schonfeld, 2007). Thus, although in recent decades the need to moderate the use of textbooks has been highlighted (Del Carmen & Jiménez, 2010), it has been shown that the majority of teachers use textbooks in their classrooms, making them the main source of information available to students and the most used resource in the classroom (Caixeta de Castro Lima & De Souza Silva, 2010). In this sense, teachers find security in them, so they tend to defend their use, because it facilitates teaching as they are a source of organisation, guidance, and consultation and offers material already elaborated in a visually attractive manner for the students (López Hernández, 2011; Monereo, 2010). Furthermore, Kova and Moharthat (2022) indicate that for some types of reading printed texts are better than screens, and interactivity and dynamic design require coherent design to improve reading performance and higher-level thinking skills. Therefore, one of the keys may lie in the choice of a suitable textbook. Indeed, Pavešić and Cankar (2022) observed that there were significant differences in knowledge and attitudes toward mathematics and science subjects in primary schools between groups of students using different textbooks and even revealed that certain contents were not taught in schools because they were not present in outdated editions of textbooks.

The development of scientific skills depends, in addition to good teacher practices (Blanco-López et al., 2015; Lupión-Cobos et al., 2017), on the quality of the textbooks, which are an important mediator of student learning. Therefore, the aim of this work is to assess the weight of evolution and evolution-related terms in both the APEC and the teaching activities proposed by the textbooks of the last three years of PE. More specifically, the following research questions are raised:

- To what extent are evolution and evolution-related terms present in the PE curricula corresponding to all the autonomous communities of Spain?
- What are the characteristics of the activities related to evolution in PE textbooks in both NatSci and SocSci in terms of their dimension, situation in the text, contextualisation, and material necessary?
- What specific skills associated with scientific competence allow these activities to be developed?
- Are there any differences between subjects (NatSci and SocSci) to which the activities are directed regarding the skills they promote?

Method

Analysis of the curricula

Table 1 shows the 17 different APEC for each of the 17 autonomous communities of Spain. Sá-Pinto et al. (2021) described a framework to assess school curricula according to whether the students address the ideas, concepts, and mechanisms that are necessary to understand evolution. However, since the diversity of the APEC documents in terms of their extension and arrangement was high (Alonso et al., 2015), the 'text mining' technique (Kaushik & Naithani, 2016) was selected to assess a global analysis.

As mentioned, the concepts regarding the inheritance of traits, natural selection/ artificial selection, adaptation, and biodiversity are signalled to set the scaffolding, level by level, to the knowledge of evolution by the *Next Generation Science Standards* (NGSS Leas States, 2013). Thus, besides 'evolution', the words chosen to be searched for in the NatSci area of the APEC as respectively representative of the previously mentioned disciplinary core ideas were 'inheritance', 'selection', 'adaptation', 'biodiversity' and 'people'. Since evolution helps to explain many socio-scientific issues (WGTE, 1998) and thus in Spain, the topic of evolution is also included in the SocSci area, the analysis was also driven in the SocSci area of the APEC. In addition, while performing the analysis, the words 'extinction' and 'time' came up, and the authors of this work decided to include them in the analysis: in the case of 'extinction' because of its relationship with biodiversity and in the case of 'time' because evolution involves time. However, the words (and/or their derivatives) were only accounted for when related to evolution; specifically, 'selection' was not considered when it referred to the duty of the students to select information or 'evolution' when referring to the progress of the students.

Table 1

Primary Education curricula per autonomous community and the corresponding decrees

Autonomous Community	Normative
Andalusia	97/2015 Decree of March the 3rd
Aragon	ECD/850/2016 Order of July the 29th
Asturias	82/2014 Decree of August the 28th
Balearics	32/2014 Decree of July the 18th
Canary Islands	89/2014 Decree of August the 1st
Cantabria	27/2014 Decree of June the 5th
Castile La Mancha	54/2014 Decree of July the 10th
Castile and Leon	26/2016 Decree of July the 21st
Catalonia	119/2015 Decree of June the 23rd
Valencia	Decrees 108/2014, of July the 4th and 88/2017 of July the 7th
Estremadura	103/2014 Decree of June the 10th
Galicia	05/2014 Decree of September the 4th
Madrid	89/2014 Decree of July the 24th
Murcia	198/2014 Decree of September the 5th
Navarra	60/2014 Regional Decree of July the 16th
Basque Country	236/2015 Decree of December the 22nd
La Rioja	24/2014 Decree of June the 13th

While performing the analysis, the words 'extinction' and 'time' were seen, and the authors of this work decided to include them in the analysis. As mentioned, the APEC widely differed, also regarding their length. Thus, the frequency with which the selected terms were mentioned was relativised to the addition of the frequencies with which each of the eight terms appeared in each area (Eq. 1) (Ortuzar-Iragorri & Diez-López, 2021).

$$f_{Ri} = \frac{f_i}{\sum_i^8 f_i}$$ [Eq. 1]

Where f_{Ri} = Relative frequency for the i term in the area.
f_i = Absolute frequency of the i term in the area.

Textbook analysis

In Spain, the first concept in the progression to the evolution model, the topic of human reproduction, is usually addressed from the 4th EP grade onwards. Accordingly, the teaching activities proposed by textbooks for the last three years of Primary Education (9–10-, 10–11, and 11–12-year-old children in the 4th, 5th and 6th grades, respectively) of three widely established Spanish publishers, SM, Santillana, and Anaya, (hereinafter A, B, and C) were analysed (18 textbooks). The textbooks corresponded to the two subjects of interest (NatSci and SocSci).

In total, 105 activities were analysed, distributed, as shown in Table 2.

Table 2
Distribution of the activities analysed according to the editorials and curricular area

Subject	4th grade			5th grade			6th grade		
	Ed A	Ed B	Ed C	Ed A	Ed B	Ed C	Ed A	Ed B	Ed C
NatSci	0	5	11	12	6	16	0	0	13
SocSci	7	3	6	3	1	1	15	1	5

As previously described by García Barros et al. (2021), two aspects were considered for the analysis of the activities: characterisation and scientific skills.

First, for the characterisation of the activities, their length, situation, context and material needed were taken into account (García Barros et al., 2021). Furthermore, taking into account the disciplinary core ideas regarding evolution previously searched in the different APEC, the concept related to evolution that was most present in the activities was analysed.

Second, for the scientific skills that the activities enable to work on, the scientific competence described in the Program for International Student Assessment (PISA) (OECD, 2019) and the skills linked which are related to higher-order cognitive processes (i.e., applying, analysing, evaluating) and to lower-order cognitive processes (i.e., remembering, analysing, evaluating) were considered (García Barros et al., 2021). Specifically, four types of categories were established: a) Type 1: basic cognitive abilities, such as identifying characteristics, establishing relationships, classifying, comparing, and defining; b) Type 2: abilities related to the use of knowledge to describe, explain causes or effects or justify phenomena scientifically using a theoretical model; c) Type 3: abilities related to the search of information, from observation or the use of other sources of information, to the approach to inquiry, the formulation of hypotheses, the design of experiments, carrying out experiments; and d) Type 4: abilities linked to the scientific interpretation of data and evidence (using evidence/data; formulating conclusions and elaborating arguments justifying the validity of an idea or the adoption of behaviour, based on theoretical or empirical knowledge) (Table 3).

The analysis was performed independently by the two authors; when disagreements or doubts arose, they were discussed until a consensus was reached.

When comparisons were made, the Chi-square test (SPSS-version 27) was used, and a significance level of p 0.05 was considered.

Table 3

Criteria used for the analysis of the scientific skills that activities enable to work

	Types	Abilities	Examples
Scientific abilities	Type 1	Identify characteristics	Identify two adaptations of the living being in the photograph.
		Classify	Classify in a table the natural and artificial changes that can destroy ecosystems.
		Compare	Look at the drawings on the two pages. Note the actions that damage the environment (marked with red dots) and indicate the actions taken to repair this damage (marked with blue dots).
		Define	Write in your notebook the meaning of the following: species, endangered, captive breeding, and biodiversity.
	Type 2	Describe facts or phenomena	Look at both pictures and describe the
		Explain/justify	The following images
	Type 3	Observe	Observe the following images and describe….
		Search for information	Find information on what creatures living on a coastline with daily high and low tides have to adapt to.
		Propose hypothesis	What do you think would occur if they were no seas or oceans? Would there be life? Why?
		Design experiments	-
		Experiment	-
	Type 4	Use evidence/data	-
		Formulate conclusions	Explain how the artificial elements and the actions of human beings influence the environment shown in the image and conclude what measures we can take to reduce their impact.
		Elaborate arguments	-

Note. Adapted from García Barros et al., 2021.

Results

Overall, the word 'evolution' was mentioned 11 times in the NatSci area of the 17 APEC. That is less than once per APEC. When it was mentioned, it was usually in the NatSci introductive area of the APEC within the phrase 'The development of Science and scientific activity is one of the essential keys to understanding the evolution of humanity'. Such a phrase refers to the impact of science on humanity rather than to the concept of biological evolution. In the case of SocSci, the word 'evolution' appears 206 times at the 17 APEC. That is 12 times on average per APEC, more than all the times the term was found in the NatSci area of the APEC. However, it refers to the historical, cultural, demographic, and landscape evolution of humans and their settings.

Regarding the words that represent the progression to the evolution model (inheritance, selection adaptation, biodiversity and the terms extinction and time), 'extinction' was, on average, the word whose relative frequency (58.7%) was highest in the NatSci area of the APEC (Figure 1A) followed by 'biodiversity' (18.6%), 'adaptation' (8.2%), 'time' (2.5%) and inheritance (1.8%). 'Selection' (0.0%) was not mentioned in any of the NatSci areas of the APEC. It is also noticeable that while all the other words were not mentioned in some of the NatSci areas of the APEC, 'extinction' was mentioned in all of them, except for Catalonia, at least once. In fact, its relative frequency is 100% in the NatSci area of the PE curricula of two autonomous communities (Madrid and Murcia) (Table 4). As expected, 'extinction' and 'biodiversity' were often found together in Block 3 (living beings) in the sense that the extinction of species causes a loss in biodiversity.

Table 4

Relative frequency with which each of the selected words appears in the autonomous curricula, in the NatSci field and in the SocSci field

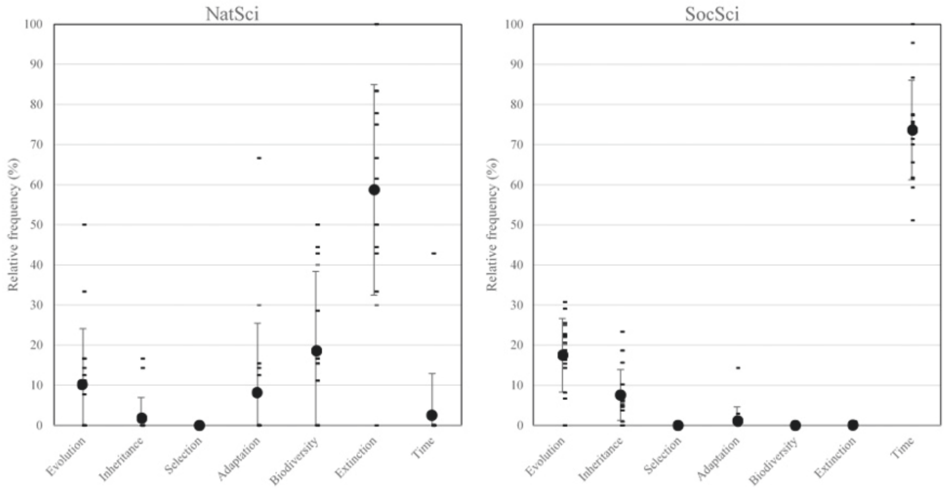
Autonomous community	Relative frequency (%)													
	Evolution		Inheritance		Selection		Adaptation		Biodiversity		Extinction		Time	
	Nat Sci	Soc Sci	Nat Sci	Soc Sci	Nat Sci	Soc Sci	Nat Sci	Soc Sci	Nat Sci	Soc Sci	Nat Sci	Soc Sci	Nat Sci	Soc Sci
Andalusia	14.3	25.6	14.3	23.3	0.0	0.0	0.0	0.0	28.6	0.0	42.9	0.0	0.0	51.1
Aragon	16.7	14.3	16.7	7.6	0.0	0.0	0.0	2.9	16.7	0.0	50.0	0.0	0.0	75.2
Asturias	7.7	30.8	0.0	7.7	0.0	0.0	15.4	0.0	15.4	0.0	61.5	0.0	0.0	61.5
Balearics	0.0	15.4	0.0	10.3	0.0	0.0	0.0	0.0	50.0	0.0	50.0	0.0	0.0	74.4
Canary Islands	0.0	25.0	0.0	5.0	0.0	0.0	0.0	0.0	16.7	0.0	83.3	0.0	0.0	70.0
Cantabria	0.0	18.8	0.0	15.6	0.0	0.0	66.7	0.0	0.0	0.0	33.3	0.0	0.0	65.6
Castile-La Mancha	33.3	20.6	0.0	3.7	0.0	0.0	0.0	0.0	0.0	0.0	66.7	0.9	0.0	74.8
Castile and León	11.1	0.0	0.0	4.6	0.0	0.0	0.0	0.0	11.1	0.0	77.8	0.0	0.0	95.4
Catalonia*	0.0	22.7	0.0	0.0	0.0	0.0	14.3	0.0	42.9	0.0	0.0	0.0	42.9	77.3
Valencia	16.7	8.2	0.0	6.1	0.0	0.0	0.0	14.3	0.0	0.0	83.3	0.0	0.0	71.4
Extremadura	12.5	22.0	0.0	18.6	0.0	0.0	12.5	0.0	0.0	0.0	75.0	0.0	0.0	59.3
Galicia	0.0	20.2	0.0	5.6	0.0	0.0	30.0	0.0	40.0	0.0	30.0	0.0	0.0	74.2
Madrid	0.0	6.7	0.0	6.7	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	86.7
Murcia	0.0	16.3	0.0	6.1	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	77.6
Navarra	11.1	22.3	0.0	1.0	0.0	0.0	0.0	0.0	44.4	0.0	44.4	1.0	0.0	75.7
Basque Country	50.0	29.1	0.0	7.3	0.0	0.0	0.0	1.8	0.0	0.0	50.0	0.0	0.0	61.8
La Rioja	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	50.0	0.0	0.0	100.0

Note. *The areas 'Knowledge of the Natural Environment' and 'Knowledge of the Social and Cultural Environment' in Catalonia are equated to the Natural Sciences and Social Sciences areas, respectively.

Regarding the SocSci area, the relative frequencies of the words that represent the progression to the evolution model were the following: 'time' (73.6%), 'evolution' (17.5%), 'inheritance' (7.6%), 'adaptation' (0.3%), 'extinction' (0.1%), 'selection' (0%), and 'biodiversity' (0%) (Figure 1B). The term 'time' was frequently mentioned within Block 4: *traces of time,* which embeds the word in its title. However, its mentioning refers to demographic, landscape, and cultural evolution, and it might have been accompanied by the very same word 'evolution' itself (i.e., '[...] to initiate students in the knowledge of the construction and **evolution** of societies over **time**, starting from a contextualisation in their closest environment').

Figure 1

Relative frequency of the words in the NatSci and SocSci areas of the autonomic PE curricula and their average value. The bar errors accompanying the average value correspond to the standard deviation.



In relation to the textbooks, Table 5 shows the characteristics of the activities analysed. Specifically, more than 77% of the proposals responded to a reduced format (short questions). The activities were spread evenly across the different topics, although there were generally more activities at the end of each topic than at the beginning or throughout it. In relation to the context, it is interesting to note that, even in the case of SocSci, most of the activities were integrated into an environmental context. As expected, in the SocSci textbooks, there were significantly more activities framed in a socio-technological context than in the NatSci textbooks (90.48% and 79.37%, respectively). Pencil and paper were the material most frequently needed in both topics, followed successively by the use of drawings and diagrams and bibliographic or websites. In general, more material apart from pencil and paper was needed to do the activities from the NatSci textbooks. Finally, only in activities from the NatSci textbooks was practical material needed (Table 5).

Table 5

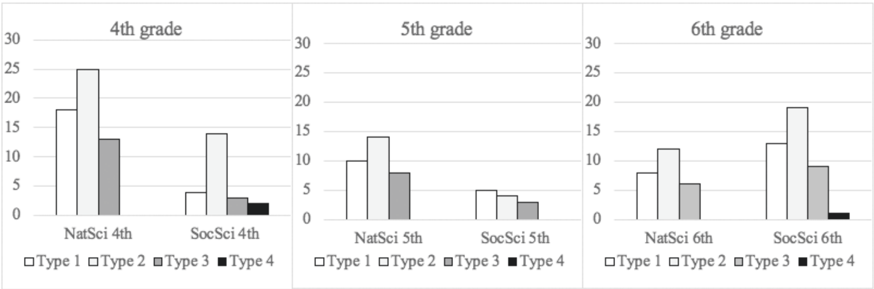
Descriptive statistics of the characterisation of the activities, core ideas, and type of scientific skills: Relative frequency, χ^2 results and p-values in comparisons of Nature Sciences (NatSci) activities and Social Sciences (SocSci) activities

		NatSci (%)	SocSci (%)	χ^2	P
Length	Short	77.78	85.71	1.029	0.310
	Broad	22.22	14.28		
Situation	Initial/Integrated	46.03	30.95	2.388	0.122
	Final	53.97	69.05		
Context	Day to day	9.52	0	4.242	4.242
	Social/technological	25.39	59.52	12.331	<0.001*
	Environmental	79.37	90.48	2.293	0.130
	Academic	17.46	14.29	0.187	0.187
Material needed	Pen and paper	96.83	100	1.359	0.244
	Practical material	1.59	0	0.673	0.412
	Drawings/diagrams	11.11	2.38	2.729	0.099
	Bibliographic material/Webs	12.70	2.38	3.243	0.064
Core ideas	Inheritance	4.76	0	2.059	0.151
	Selection	14.29	7.14	1.270	0.260
	Adaptation	49.21	66.67	3.121	0.077
	Biodiversity	38.10	85.71	23.333	<0.001*
	Extinction	20.63	45.24	7.199	0.007*
Scientific skills	Type 1	57.14	52.38	0.231	0.631
	Type 2	80.95	88.10	0.948	0.330
	Type 3	42.86	35.71	0.536	0.464
	Type 4	0	7.14	4.632	0.031*

With regard to the core ideas, the most present in the activities from NatSci textbooks was 'adaptation' (49.21%) and, in the case of SocSci textbooks, 'biodiversity' (85.71%), whose presence was surprisingly significantly larger than in the activities from the NatSci textbooks (38.10%). 'Inheritance' and 'selection' are the core ideas with less presence in both cases, although there was a slightly higher presence of them in NatSci textbooks than in SocSci textbooks (Table 5).

In relation to the skills promoted by the activities, it can be observed (Figure 2) that Type 2 skills were the most frequent in both subjects, followed successively by Type 1, 3, and 4 skills. In fact, considering that the student can work on one or several types of skills with each activity, most activities included Type 2 skills along with other types of activities in both cases. Although the frequency of Type 4 activities was significantly higher in SocSci than in NatSci, it is interesting to note that, in general, there was hardly any presence of Type 4 activities (0 in NatSci; 3 in SocSci) (Table 5).

Figure 2
Types of scientific skills promoted in the NatSci and the SocSci textbook activities in 4th, 5th, and 6th grades



Discussion

The results of this study show the concept of biological evolution is only slightly present in the APEC in Spain. In the case of NatSci, the term 'evolution' is not included in every APEC; in most cases, it refers to the impact of science on humanity rather than to the concept of biological evolution. The same occurs in the SocSci area, where 'evolution' refers to the historic, cultural, demographic and landscape evolution of humans and their settings. In fact, when analysing the presence of the progression of ideas needed to achieve the evolution model, such as inheritance, selection, adaptation, and biodiversity (Bybee, 2012), we observe an important gap in the construction of the model of evolution in the APEC in Spain. Thus, only the NatSci area covers the topic regarding biodiversity, which represents only the last step of the progression to the knowledge of the NGSS model of evolution (NGSS Lead States, 2013). It should be noted that the idea of selection is not present in any of the areas of any of the APEC, neglecting the aspects of evolution regarding the evidence for shared ancestry, the genetic variation impact on reproduction chances and how natural selection leads to adaptation (Bybee, 2012). These results differ from other countries, such as Sweden, France, England, and the United States, where the core ideas of evolution are included in their EP curricula, and designed progressions are offered in additional official documents (Vázquez-Ben & Bugallo-Rodríguez, 2018). Soon, the APEC will be restructured according to the new Spanish Education law (LOMLOE) and, seemingly, the NatSci and SocSci areas of the APEC will be merged. Such a scenario offers the chance to grasp a deeper view of evolution by studying, in connection, aspects of evolution across topics in areas that were previously disconnected.

In contrast, with regard to the characterisation of the activities, in general, they respond to a short format, mostly at the end of each topic, which requires few resources, with drawings/sketches followed by a bibliography, being the most requested, while specific material for observation/experimentation is hardly necessary. This is in line with previous studies where they observed that, in spite of the changes in format, the textbooks maintain a practically identical structure (Hidalgo Herrera, 2014), with traditional learning processes, in which the exercises are sometimes simple, mechanical, and repetitive and, in many cases, they are limited to filling in gaps, looking at pictures, and copying sentences (Molina Puche & Alfaro Romero, 2019). In relation to the context, most of the activities are integrated into an environmental context. Such fact, together with the fact that the core ideas most present in the NatSci area and the SocSci area are 'adaptation' and the change in 'biodiversity' often as consequences of human activity, seemingly respond to the strong desire to educate children about sustainability in a sustainable manner.

Relegating the evolution to the SocSci area, the topic is addressed from a cultural and social perspective. This may lead to a possible loss of the scientific perspective when addressing the topic, failing to promote the scientific education of citizens in accordance with the social and environmental demands of our times. Indeed, cognitive factors, such as reasoning and perception, influence effective decision making and those with functional scientific literacy will use science content knowledge to make informed decisions (Zohar & Nemet, 2002). Therefore, individuals' conceptions of evolution can alter the manner in which they consider personal and social issues (Brehm et al., 2003) and can also influence socio-scientific decision-making (Sadler, 2005). Thus, understanding evolution is necessary to make effective and informed decisions about socio-scientific issues such as cloning, stem cell research, gene therapy, vaccines, and biodiversity, among others.

Finally, in relation to the types of scientific skills promoted by the activities related to evolution, we observe that the activities mainly promote Type 2 skills, followed successively by Type 1, 3, and 4 skills. In all cases, the skills that are usually prioritised are those corresponding to the lower cognitive level (identify, describe, observe) and higher cognitive skills such as 'design experiments', 'use evidence/data' or 'elaborate arguments' are not present, or they are very scarce in the textbooks analysed. Other studies have emphasised that school textbooks fail to provide students with satisfactory opportunities to promote scientific skills and facilitate a better understanding of scientific ideas and concepts (García Barros et al., 2021; Martínez Losada & García Barros, 2003; Sideri & Skoumios, 2021).

Therefore, considering teaching should provide opportunities for students to use inquiry skills (Osborne, 2014) and apply them in a variety of contexts and situations (De Pro, 2013), the curricula and textbooks activities related to evolution should avoid 'rote' knowledge aimed at 'knowing the world', but not at explaining or investigating it and promote higher cognitive scientific skills.

Conclusions

In conclusion, the APEC in Spain and science textbooks of the fourth, fifth and sixth PE grades have significant gaps when addressing evolution; therefore, they do not provide opportunities for students to develop scientific skills deeply. As Vázquez-Ben and Bugallo-Rodríguez (2018) suggested, if we approach the teaching of evolution too late, learning it will be more difficult. In fact, studies show that students who do not start with certain science topics until secondary school rarely manage to reach the same learning objectives as those who achieved them in primary school (Marco-Bujosa & Levy, 2016). This indicates that helping students to build the model of evolution requires starting at early stages so that they can progress in biological knowledge to be able to make decisions and act correspondingly.

The upcoming restructuring of the APEC contents to accommodate them to the new LOMLOE education law provides the opportunity to update the evolution contents. Such a reformation should include contents and activities on evolution that students can approach both from the SocSci and NatSci areas and require the development of scientific skills.

References

Alonso, D. M., Fernández-Río, J., Giménez, A. M., & Sabori, J. A. P. (2015). Análisis de los currículos autonómicos LOMCE de Educación Física en Educación Primaria [Analysis of the regional LOMCE curricula for physical education in primary education]. *Retos. Nuevas Tendencias en Educación Física, Deporte y Recreación, 28,* 15–20. https://recyt.fecyt.es/index.php/retos/article/view/34822/19057

Alters, B., & Nelson, C. (2002). Perspective: teaching evolution in higher education. *Evolution, 56*(10), 1891–1901. https://www.jstor.org/stable/3094632

Blanco-López, Á., España-Ramos, E., & Franco-Mariscal, A. J. (2017). Estrategias didácticas para el desarrollo del pensamiento crítico en el aula de ciencias [Didactic strategies for the development of critical thinking in the science classroom]. Ápice, *1*(1), 107–115. https://ruc.udc.es/dspace/bitstream/handle/2183/19977/Apice_2017_1_1_art._7.pdf

Brem, S. K., Ranney, M., & Schindel, J. (2003). Perceived consequences of evolution: College students perceive negative personal and social impact in evolutionary theory. *Science Education, 87*(2), 181–206. https://doi.org/10.1002/sce.10105

Bybee, R. W. (2012). The next generation of science standards: Implications for biology education. *The American Biology Teacher*, *74*(8), 542–549. https://doi.org/10.1525/abt.2012.74.8.3

Caixeta de Castro Lima, M. E., & De Souza Silva, P. (2010). Critérios que professores de química apontam como orientadores da escolha do livro didático [Criteria that chemistry teachers apply as counselors of the choice of didactic books]. *Ensaio – Pesquisa Educação em Ciências, 12*(2), 121–135. https://doi.org/10.1590/1983-21172010120208

De Pro Bueno, A. J. (2013). Enseñar procedimientos: por qué y para qué [Teaching procedures: why and what for]. *Alambique: Didáctica de las ciencias experimentales, 73,* 69–76.

Del Carmen, L. M., & Jiménez, P. (2010). Los libros de texto: un recurso flexible [Textbooks: a flexible resource]. *Alambique: Didáctica de las ciencias experimentales, 66,* 48–55.

Demastes, S., Settlage, J., & Good, R. (1995). Students' conceptions of natural selection and its role in evolution: Cases of replication and comparison. *Journal of Research in Science Teaching, 32*(5), 535–550. https://doi.org/10.1002/TEA.3660320509

Deniz, H., & Borgerding, L. A. (2018). *Evolution Education around the Globe*. Springer.

Eurydice (2022). *Organización y Administración general del Sistema Educativo* [Organization and general administration of the educational system]. https://eacea.ec.europa.eu/national-policies/eurydice/content/organisation-and-governance-79_es

Garcia Barros, S. G., Losada, C. M., & Rivadulla López, J. R. (2021). Actividades de textos escolares. Su contribución al desarrollo de la competencia científica [School textbook activities. Their contribution to the development of scientific competence]. *Enseñanza de las Ciencias. Revista de investigación y experiencias didácticas*, *39*(1), 219–238. https://doi.org/10.5565/rev/ensciencias.3099

Gilbert, J. K. (2004). Models and modelling: Routes to more authentic science education. *International Journal of Science and Mathematics Education*, *2*(2), 115–130. https://doi.org/10.1007/s10763-004-3186-4

Hidalgo Herrera, M. (2014). ¿Han evolucionado los libros de texto? Análisis comparativo del Medioevo en manuales escolares del siglo XX y XXI [Have textbooks evolved? Comparative analysis of the Middle Ages in school textbooks of the 20th and 21st centuries]. *CLIO. History and History teaching, 40*. http://clio.rediris.es/n40/articulos/Hidalgo2014.pdf

Jiménez-Aleixandre, M. P., & Crujeiras, B. (2017). Epistemic Practices and Scientific Practices in Science Education. In K. S. Taber, B. Akpan (Eds.), *Science education*. *New directions in mathematics and science education* (pp. 69–80). SensePublishers. https://doi.org/10.1007/978-94-6300-749-8_5

Kaushik, A., & Naithani, S. (2016). A comprehensive study of text mining approach. *International Journal of Computer Science and Network Security, 16*(2), 69.

Kovač, M., & Kepic Mohar, A. (2022). The changing role of textbooks in primary education in the digital era: What can we learn from reading research? *CEPS Journal, 12*(2), 11–28. https://doi.org/10.26529/cepsj.1290

López Hernández, A. (2007). Libros de texto y profesionalidad docente [Textbooks and teaching professionalism]. *Avances En Supervisión Educativa 6*, 1–13. https://redined.educacion.gob.es/xmlui/bitstream/handle/11162/170178/282-Texto%20del%20art%c3%adculo-312-1-10-20160309.pdf?sequence=1&isAllowed=y

Lupión-Cobos, T., López-Castilla, R., & Blanco-López, Á. (2017). What do science teachers think about developing scientific competences through context-based teaching? A case study. *International Journal of Science Education, 39*(7), 937–963. https://doi.org/10.1080/09500693.2017.1310412.

Marco-Bujosa, L. M., & Levy, A. J. (2016) Caught in the balance: An organizational analysis of science teaching in schools with elementary science specialists. *Science Education, 100*(6), 983–1008. https://doi.org/10.1002/sce.21239

Martínez Losada, C., & García Barros, S. (2003). Las actividades de primaria y ESO incluidas en libros escolares. ¿Qué objetivo persiguen? ¿Qué procedimientos enseñan? [Primary and secondary education activities included in school books. What goal are they pursuing? What procedures do they teach?]. *Enseñanza de las Ciencias, 21*(2), 243–264. https://doi.org/10.5565/rev/ensciencias.3929

Molina Puche, S., & Alfaro Romero, A. (2019). Ventajas e inconvenientes del uso del libro de texto en las aulas de Educación Primaria. Percepciones y experiencias de docentes de la Región de Murcia [Advantages and disadvantages of the use of the textbook in the classrooms of primary education. Perceptions and experiences of teachers in the Region of Murcia]. *Revista Electrónica Interuniversitaria de Formación del Profesorado, 22*(2), 179–197. https://doi.org/10.6018/reifop.22.2.332021

Monereo Font, C. (2010). ¡Saquen el libro de texto! Resistencia, obstáculos y alternativas en la formación de los docentes para el cambio educativo [Get out the textbook! Resistance, obstacles and alternatives in teacher training for educational change]. *Revista de educación, 352*, 583–597.

NGSS Lead States. (2013). Next generation science Standards: For states, by states. The National Academies Press. http://www.nextgenscience.org/

National Science Teaching Association (NSTA), 2013. *Position statement: The Teaching of Evolution*. https://www.nsta.org/nstas-official-positions/teaching-evolution

Nehm, R., & Schonfeld, I. (2007). Does increasing biology teacher knowledge of evolution and the nature of science lead to greater preference for the teaching of evolution in schools? *Journal of Science Teacher Education, 18*(5), 699–723. https://doi.org/10.1007/s10972-007-9062-7

Organization for Economic Cooperation and Development (OECD). (2019). *PISA 2018 Science Framework*, in PISA 2018 Assessment and Analytical Framework, OECD Publishing. https://doi.org/10.1787/f30da688-en

Organic Law 8/2013 of December the 9th for the Quality of Education. *Boletín Oficial del Estado*, *295*, de 10 de diciembre de 2013, 97858–97921. https://www.boe.es/boe/dias/2013/12/10/pdfs/BOE-A-2013-12886.pdf

Organic Law 3/2020 of December the 29th on Education. *Boletín Oficial del Estado*, 340, de 30 de diciembre de 2020, 122868–122953. https://www.boe.es/boe/dias/2020/12/30/pdfs/BOE-A-2020-17264.pdf

Ortuzar-Iragorri, A., & Díez-López, J. D. (2021). El suelo en el currículum de Educación Primaria española. Un análisis geográfico [The soil in the Spanish Primary Education curriculum. A geographic analysis]. In Universidad de Córdoba: Asociación Española de Profesores e Investigadores de Didáctica de las Ciencias Experimentales (Eds.), *29 Encuentros de Didáctica de las Ciencias Experimentales y 5ª Escuelas de Doctorado: 10, 11 y 12 de Febrero 2021* (pp. 1209–1216).

Symposium conducted at the meeting of Universidad de Córdoba and APICE, Córdoba.

Osborne, J. (2014). Teaching scientific practices: Meeting the challenge of change. *Journal of Science Teacher Education, 25*(2), 177–196. https://doi.org/10.1007/s10972-014-9384-1

Pavešić, B. P., & Cankar, G. (2022). Textbooks and students' knowledge. *CEPS Journal, 12*(2), 29–65. https://doi.org/10.26529/cepsj.1283

Sá-Pinto, X., Realdon, G., Torkar, G., Sousa, B., Georgiou, M., Jeffries, A., Korfiatis K., Paolucci S., Pessoa P., Rocha J., Stasinakis P.K., Cavadas B., Crottini A., Gnidovec T, Nogueira T., Papadopoulou P., Piccoli C., Barstad J., Dufour H.D., Pejchinovska M., Pobric A., Cvetković D & Mavrikaki, E. (2021). Development and validation of a framework for the assessment of school curricula on the presence of evolutionary concepts (FACE). *Evolution: Education and Outreach, 14*(1), 1–27. https://doi.org/10.1186/s12052-021-00142-2

Sadler, T. D. (2005). Evolutionary theory as a guide to socioscientific decision making. *Journal of Biological Education, 39*(2), 68–72. https://doi.org/10.1080/00219266.2005.9655964

Sideri, A., & Skoumios, M. (2021). Science process skills in the Greek primary school science textbooks. *Science Education International 32*(3), 231–236. https://doi.org/10.33828/sei.v32.i3.6

Smith, M. (2010). Current status of research in teaching and learning evolution: II. Pedagogical issues. *Science and Education, 19*(6), 523–538. https://doi.org/10.1007/s11191-009-9215-5

Vázquez-Ben, L., & Bugallo-Rodríguez, Á. (2018). El modelo de evolución biológica en el curriculum de Educación Primaria: Un análisis comparativo a nivel internacional [The biological evolution model in the Primary Education curriculum: A comparative analysis at an international level]. *Revista Eureka sobre Enseñanza y Divulgación de las Ciencias, 15*(3), 3101–3101.

Working Group on Teaching Evolution (WGTE). (1998). *Teaching about evolution and the nature of science.* National Academy Press.

Zohar, A., & Nemet, F. (2002). Fostering students' knowledge and argumentation skills through dilemmas in human genetics. *Journal of Research in Science Teaching 39*(1), 35–62. https://doi.org/10.1002/tea.10008

Biographical note

Mª Arritokieta Ortuzar Iragorri, PhD, is an assistant professor in the field of didactics of experimental sciences on the Faculty of Education of Bilbao at University of the Basque Country, Spain. She researches on context selection for science teaching in First Childhood, Primary Education and Higher Education to favour the students´ scientific competence as well as sustainability and/or the students' caretaking skills.

Teresa Zamalloa, PhD, is an assistant professor in the field of didactics of experimental sciences on the Faculty of Education of Bilbao at University of the Basque Country, Spain. Her research interests include the teaching/learning of geology (teacher profile, interpretation centers and student attitudes) and the teaching/learning of science (development of scientific competence). Nowadays she investigates on the performance of students in scientific practices so as to develop their scientific competence.